

CHAPTER 7

PRESSURE-REGULATING DEVICES

HYDRAULIC PRESSURE GAGES

Purpose. Hydraulic pressure gages (sometimes called pressure indicators) (Figure 7-1) indicate the amount of pressure in hydraulic systems. Gage dials are calibrated to show this pressure in psi.

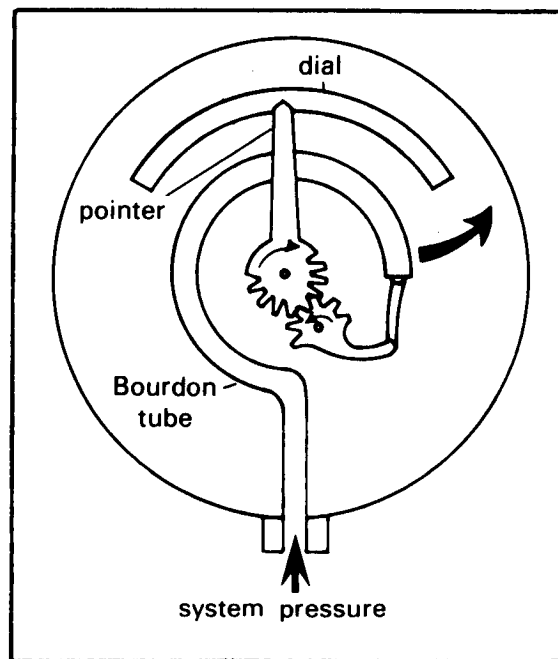


Figure 7-1. Hydraulic pressure gage.

Types. Two types of gages used are the direct-reading gage and the remote-indicating gage.

Direct-Reading Gage. This gage consists of a Bourdon tube, pointer, dial, and rain-tight case. The Bourdon tube and pointer are interconnected by gearing so that they will move together. Pressure within the hydraulic system is admitted into the Bourdon tube through a connecting line. As hydraulic system pressure increases, it causes the Bourdon tube to straighten to a corresponding degree. The change in the tube's curvature reacts on the gearing, causing the pointer to move to a higher reading on the dial. As hydraulic system pressure decreases, the Bourdon tube curls back toward its original shape. This causes the pointer to fall back to a lower dial reading. Pressure-gage snubbers are usually used with hydraulic pressure gages to dampen pointer oscillations.

Remote-Indicating Gage. In the remote-indicating gage, the gage transmitter contains a Bourdon-tube diaphragm, or bellows, where hydraulic

system pressure is admitted through a connecting line. The Burdon-tube diaphragm reacts to pressure changes in a manner similar to that of the direct-reading gage. The diaphragm's movement produces electrical signals that are transmitted through connecting wiring to the indicator unit, where they cause the indicator pointer to move.

PRESSURE SWITCHES

Purpose. A pressure switch opens or closes an electrical circuit in response to a predetermined hydraulic pressure entering the switch from a connected source. Pressure switches on Army aircraft serve two main purposes. One is to close the circuit of a warning light that shows low pressure in a system. The other is to affect the circuits of solenoid valves in aircraft having dual hydraulic boost control systems; this ensures that operating pressure to one boost system cannot be shut off unless the other boost system is provided with enough operating pressure to fly the aircraft. Some pressure switches are designed with two sets of contacts to provide control for the warning light and solenoid valve.

Types. Two types of pressure switches commonly used in Army aircraft are the piston-type pressure switch and the diaphragm-type pressure switch.

Piston-Type Pressure Switch. (See Figure 7-2.) This switch consists of a rectangular-shaped housing, a cylinder bore and piston, an adjustable spring for loading the piston, a microswitch, and linkage for transmitting the piston's movement to the microswitch. The housing has a port for connecting the switch to a system pressure line and an electrical receptacle for connecting the switch with an electrical circuit.

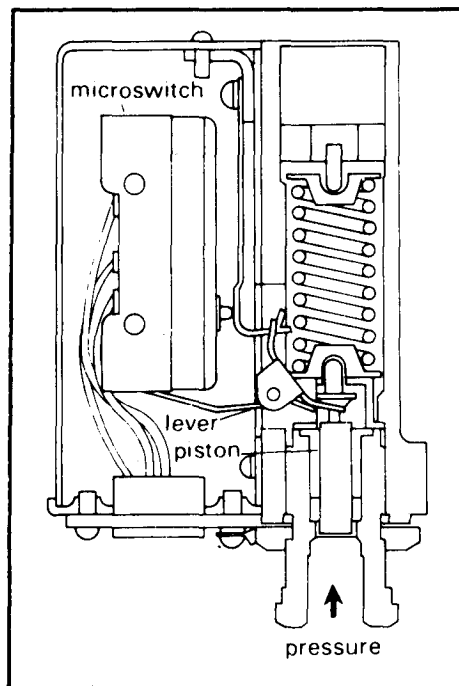


Figure 7-2. Piston-type pressure switch.

Diaphragm-Type Pressure Switch. This switch consists of a cylindrical-shaped housing, a diaphragm, an adjustable spring to load the diaphragm, a microswitch, and linkage for transmitting the diaphragm's movement to the microswitch. The housing has a port at one end for connecting the switch to a system pressure line and an electrical receptacle for connecting the switch with an electrical circuit at the other end.

Operation. The operation of the piston-type pressure switch will be discussed here; however, the diaphragm switch operates essentially on the same principles. Fluid pressure entering the port of the pressure switch acts on the face of the piston to move it against the resistance of the piston-return spring. When the fluid pressure acting on the piston becomes great enough to overcome the force of the piston-return spring, the piston's movement causes the pivoted lever of the connecting linkage between the piston and the microswitch to rotate. The pivoted lever's movement is transmitted through the idler spring to the microswitch actuating button. When the microswitch actuating button has moved a sufficient amount, the microswitch contacts move into the pressure-induced position. Normally open (NO) switches are designed so that their contacts remain open until they are closed by the action of fluid pressure against the switch position. Normally closed (NC) switches are designed so that their contacts remain closed until they are opened by the reaction of fluid pressure against the switch piston.

PRESSURE RELIEF VALVES

Purpose. Relief valves are safety devices that prevent pressure from building up to a point where it might blow seals and burst, or otherwise damage, the container in which the valves are installed. Relief valves are installed in aircraft hydraulic systems to relieve excessive fluid pressure caused by thermal expansion, pressure surges, and failure of a hydraulic pump's compensator or other-regulating devices.

Types. The two types of relief valves are the main system relief valve and the thermal relief valve.

Main System Relief Valve. This relief valve is set to open and close at pressures determined by the system in which it is installed. In systems made to operate at 3,000-psi normal pressure, the relief valve might be set to be completely open at 3,650 psi and to reseal at 3,190 psi. These pressure ranges may differ from one aircraft to another. In the open position, the relief valve sends excess pressurized fluid to the reservoir return line.

Figure 7-3 shows a typical main system relief valve with a breakdown of its component parts. The relief valve consists of a cylindrical housing containing a poppet valve and a piston assembly. Each end of the housing is made to include a wrench-holding surface and a threaded port for installing a hydraulic fitting. The housing is stamped to identify the ports as PRESS (pressure) and RET (return). The poppet valve (A), which is located just inside the pressure port, is seated over a passage through the valve. When fluid pressure at the pressure port reaches 3,650 psi, the

pressure forces the piston (B) to depress the load spring (C) and to move clear of the poppet valve. This action opens the piston's passage, and fluid flows through the valve into the return line. When pressure at the pressure port is reduced to 3,190 psi, the coil spring reseats the piston against the poppet valve. This action stops the fluid from flowing through the relief valve. If the pressure at the outlet port exceeds the pressure at the inlet port, the poppet valve will unseat, and fluid from the return line will flow through the valve into the pressure line.

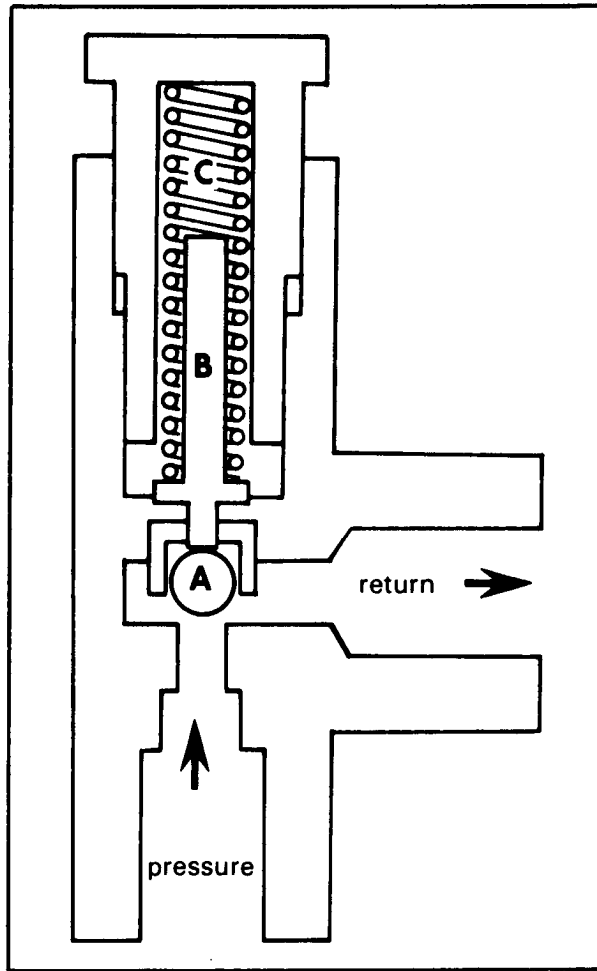


Figure 7-3. Main system relief valve with component parts.

Thermal Relief Valve. This relief valve is usually smaller than a main system relief valve. The thermal relief valve is used in systems where a check valve or a selector valve prevents pressure from being relieved through the main system relief valve. As pressurized fluid in the line builds up to an excessive amount, the valve poppet is forced off its seat, and the excess pressurized fluid flows through the relief valve to the reservoir. When system pressure decreases to a preset pressure, spring tension overcomes system pressure and forces the valve poppet to the closed position.

Maintenance. Relief valve maintenance is limited to adjusting the valve to the correct pressure setting and checking it for leaks. If a relief valve is suspected of leaking-internally, connect a flexible hose to the return port of the valve; any drippings can be caught in a container. The opening and closing pressure of the valve may also be checked in this manner if an external power source is used.

CAUTION

DO NOT ATTEMPT TO ADJUST A RELIEF VALVE WHILE IT IS INSTALLED ON AN AIRCRAFT. REMOVE AND ADJUST THE VALVE ON A TEST STAND. THE SAME RULE APPLIES TO ALL RELIEF VALVES: TURN THE ADJUSTING SCREW CLOCKWISE TO INCREASE OPENING PRESSURE AND COUNTERCLOCKWISE TO DECREASE OPENING PRESSURE.

PRESSURE-REDUCING VALVES

Purpose. A pressure-reducing valve (Figure 7-4) is used in hydraulic systems to lower the normal system operating pressure to a specified amount. It also acts as a relief valve.

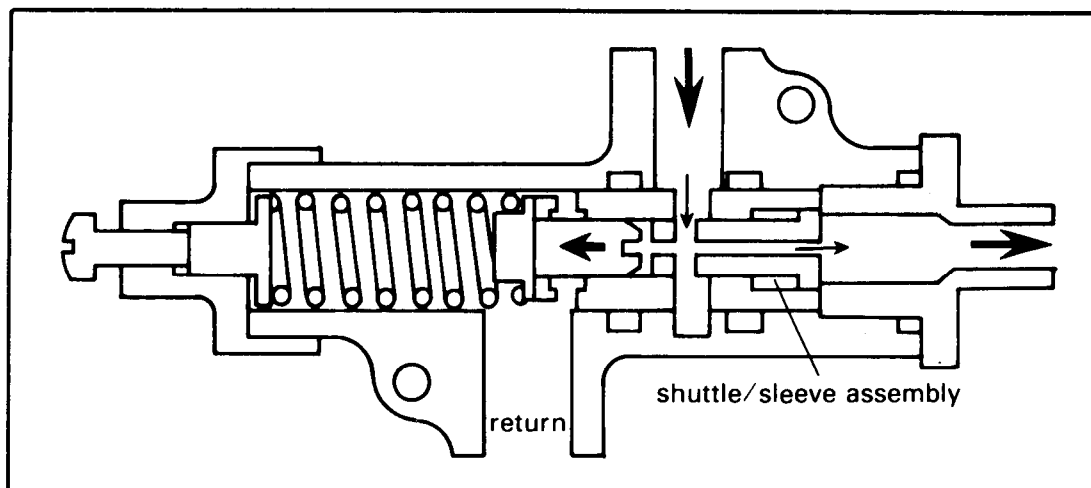


Figure 7-4. Pressure-reducing valve.

Operation. In Figure 7-4, system pressure is being ported to a subsystem through the shuttle and sleeve assembly. Subsystem pressurized fluid works on the large flange area of the shuttle, causing it to move to the left after reaching a set pressure and closing off the normal system. The valve will stay in this position until subsystem pressure is lowered. The shuttle will then move to its prior position, allowing the required amount of pressurized fluid to enter the subsystem. During the normal operation of the subsystem, the pressure-reducing valve continuously meters fluid to the system. When pressurized fluid builds up to an excess amount within the subsystem, the shuttle assembly overcomes spring tension and

moves farther to the left. This movement opens a passage to the return line, and all excess fluid is relieved. When pressure is lowered to an acceptable amount, the shuttle assembly returns to a balanced position.

ACCUMULATORS

Purpose. An accumulator in a hydraulic system stores a volume of fluid under pressure. It also acts as a cushion against pressure surges caused by pulsating fluid delivery from the pump or the system's operation. The accumulator supplements the pump's output at peak loads and may also be used to actuate a unit if the pump fails. For example, enough energy is stored in the accumulator on the AH-1G helicopter to operate the collective flight controls several times.

Many aircraft have several accumulators in the hydraulic system. There may be a main system accumulator and an emergency system accumulator. Auxiliary accumulators may also be located in various unit systems. Regardless of their number and location within the system, all accumulators store an extra volume of hydraulic fluid under pressure.

Types. Two general types of accumulators used in Army aircraft are the spherical type and the cylindrical type. Until recently, the spherical type was the one more commonly used; however, the cylindrical type has been proved to be better for high-pressure hydraulic systems.

Spherical Accumulator. The spherical accumulator is made up of two halves screwed together. (See Figure 7-5.) A synthetic rubber diaphragm divides the accumulator into two chambers. The opening at the top of the accumulator contains a screen disk. This prevents the diaphragm from coming up through the threaded opening when system pressure is depleted; this action could rupture the diaphragm. On some designs, a button-type protector fastened to the center of the diaphragm replaces the screen. The assembled component has two threaded openings. The top threaded opening connects the fluid chamber of the accumulator to the hydraulic system. The bottom threaded opening is used to install an air filler valve. When open, this valve allows air (or nitrogen) to enter the accumulator. When the valve is closed, the air (or nitrogen) is trapped within the accumulator.

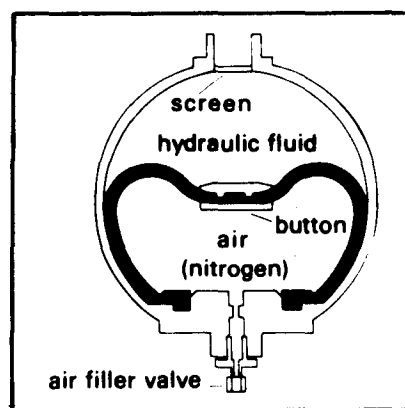


Figure 7-5. Spherical accumulator.

Cylindrical Accumulator. The cylindrical accumulator consists of a cylinder and piston assembly. (See Figure 7-6.) Caps are attached to both ends of the cylinder. The internal piston separates the fluid chamber from the air (or nitrogen) chamber. The end caps and the piston are sealed by gaskets and packings. These sealants prevent external leakage around the caps and internal leakage between the chambers. A hydraulic fitting in the end cap on the fluid side attaches the fluid chamber to the hydraulic system. An air filler valve in the other end performs the same function as the air filler valve in the spherical accumulator.

Operation. Spherical and cylindrical accumulators operate essentially the same. In operation, the compressed-air chamber is charged to a set pressure somewhat lower than the system operating pressure. This initial charge is known as the accumulator preload. To illustrate the operation of the accumulator, let us assume that the cylindrical accumulator shown in Figure 7-6 is designed for a preload of 1,300 psi in a 3,000-psi system. When the initial charge of 1,300 psi is introduced into the unit, hydraulic system pressure is zero. As air pressure is applied through the air pressure port, it moves the piston toward the opposite end until it bottoms. If the air behind the piston has a pressure of 1,300 psi, the hydraulic system pump will have to create a pressure within the system greater than 1,300 psi before the hydraulic fluid can actuate the piston. At 1,301 psi, the piston will start to move within the cylinder, compressing the air as it moves. At 2,000 psi, it will have backed up several inches. At 3,000 psi, the piston will have backed up to its normal operating position, compressing the air until it occupies a space less than one-half of the cylinder's length. When hydraulic units lower system pressure, the compressed air causes the piston to move, forcing fluid from the accumulator and supplying fluid to the hydraulic system.

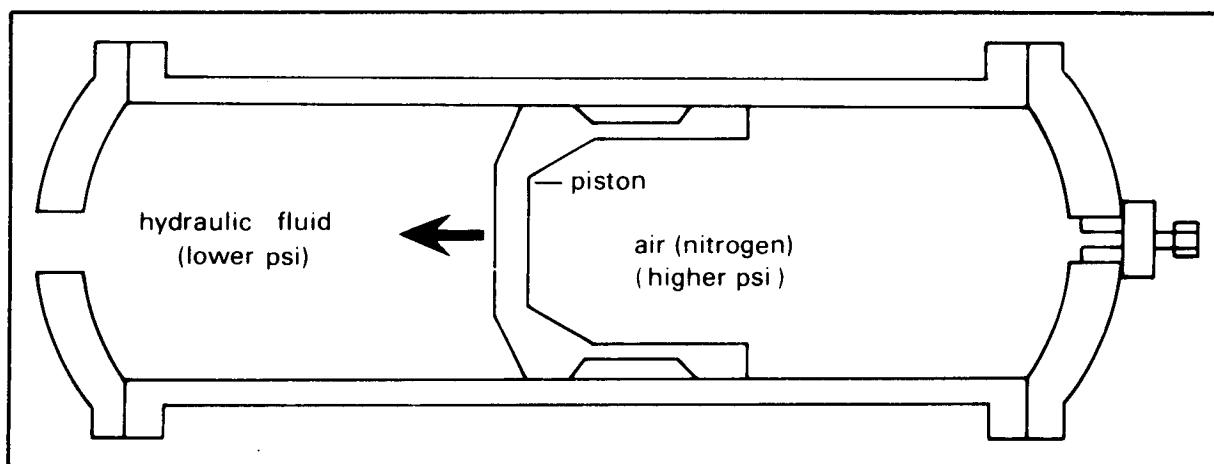


Figure 7-6. Cylindrical accumulator.

Maintenance. Examine accumulators visually for external hydraulic fluid leaks. To find an external air leak, brush the exterior with soapy water; bubbles will form wherever air is leaking. To find an internal leak, loosen the air valve assembly. If hydraulic fluid comes out of the air valve, remove and replace the accumulator.

After relieving the hydraulic system pressure, check the preload pressure by operating a hydraulically actuated unit. Most accumulators installed in Army aircraft are equipped with air-pressure gages. If they are not so equipped, a high-pressure air gage may be installed at the air preload fitting. The required pressure is stated in the maintenance manual for each aircraft.

The air preload must be completely exhausted before disassembling any accumulator. To do this, loosen the swivel nut on the air filler valve until all air is out; then remove the valve. Overhaul or repair of accumulators is not an aviation unit maintenance function. Some aviation intermediate maintenance units may have this responsibility, but it is primarily a depot maintenance function.